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Jan 23, 2013 Image ArticleAnatomy of the Sun from Mysteries of the SunImage of the Sun with cut-away portion showing the solar interior with text descriptions of the regions as follows (from inner-most to outer-most):The Suns Core Energy is generated via thermonuclear reactions creating extreme temperatures deep within the Suns core.The Radiative Zone Energy moves slowly outward, taking more than 170,000 years to radiate through this layer of the Sun.The Convection Zone Energy continues to move toward the surface through convection currents of the heated and cooled gas.The Chromosphere This relatively thin layer of the Sun is sculpted by magnetic field lines that restrain the electrically charged solar plasma. Occasionally larger plasma features, called prominences, form and extend far into the very tenuous and hot corona, sometimes ejecting material away from the Sun.The Corona The ionized elements within the corona (or solar atmosphere) glow in the x-ray and extreme ultraviolet wavelengths. NASA instruments can image the Suns corona at these higher energies since the photosphere is quite dim in these wavelength.Coronal Streamers The outward flowing plasma of the corona is shaped by magnetic field lines into tapered forms called coronal streamers, which extend millions of miles into space.This image is featured on the Mysteries of the Sun website and companion book. Credit: NASA/Jenny MottarThis image of the sun taken on October 24, 2014, shows a significant solar flare that erupted from a large active region.Photograph by NASA / GoddardLearn more about the life-giving star at the center of our solar system.ByMichael Greshko and National Geographic Staff7 min readCompared with the billions of other stars in the universe, the sun is unremarkable. But for Earth and the other planets that revolve around it, the sun is a powerful center of attention. It holds the solar system together; provides life-giving light, heat, and energy to Earth; and generates space weather.Characteristics of the sunThe sun resides some 26,000 light-years from the Milky Way's center, in a tendril of our home galaxy known as the Orion Arm. Every 230 million years, the sunand the solar system it carries with itmakes one orbit around the Milky Way's center. Though we can't feel it, the sun traces its orbit at an average velocity of 450,000 miles an hour.The sun formed more than 4.5 billion years ago, when a cloud of dust and gas called a nebula collapsed under its own gravity. As it did, the cloud spun and flattened into a disk, with our sun forming at its center. The disk's outskirts later accreted into our solar system, including Earth and the other planets. Scientists have even managed to see these planet-birthing disks around our sun's distant young cousins.Our home star is a yellow dwarf, a medium-size variety that's fairly common in our galaxy. The label yellow is misleading, though, since our sun burns a bright white. On Earth, the sun can take on warmer hues, especially at sunrise or sunset, because our planet's atmosphere scatters blue and green light the most.From our perspective, dwarf might not be the best word for our sun, either. At about 864,000 miles (1.4 million kilometers) wide, the sun is 109 times wider than Earth, and it accounts for more than 99.8 percent of the solar system's total mass. If it was a hollow ball, more than a million Earths could fit inside it. But the sun isn't hollow: It's filled with scorching gases and soups of electrically charged particles called plasma. The sun's surface temperature is about 10,000 degrees Fahrenheit (5,500 degrees Celsius), and it's 27 million degrees Fahrenheit (15.5 million Celsius) at the core.Deep in the sun's core, nuclear fusion converts hydrogen to helium, which generates energy. Particles of light called photons carry this energy through a spherical shell called the radiative zone to the top layer of the solar interior, the convection zone. There, hot plasmas rise and fall like the ooze in a lava lamp, which transfers energy to the sun's surface, called the photosphere.It can take 170,000 years for a photon to complete its journey out of the sun, but once it exits, it zips through space at more than 186,000 miles a second. Solar photons reach Earth about eight minutes after they're freed from the sun's interior, crossing an average of 93 million miles to get herea distance defined as one astronomical unit (AU).Out beyond the sun's photosphere lies the atmosphere, which consists of the chromosphere and the solar corona. The chromosphere looks like a reddish glow fringing the sun, while the corona's huge white tendrils extend millions of miles long. The chromosphere and corona also emit visible light, but on Earth's surface, they can be seen only during a total solar eclipse, when the moon passes between Earth and the sun.The corona runs far hotter than the photosphere, hitting temperatures of more than a million degrees Fahrenheit. How the corona gets so hot remains a scientific mystery, which is partly why NASA launched its Parker Solar Probe, the fastest spacecraft ever built, and the first ever sent into the corona. (Read more about the spacecraft that will touch the sun.)Solar wind and flaresIn addition to light, the sun radiates heat and a steady stream of charged particles known as the solar wind. The wind blows about 280 miles (450 kilometers) a second throughout the solar system, extending the sun's magnetic field out more than 10 billion miles. Beyond that distance, the solar wind gives way to the colder, dense material that drifts in between stars, forming a boundary called the heliopause. So far, just two spacecraftVoyager 1 and Voyager 2have crossed this cosmic threshold, which defines the start of interstellar space.Every so often, a patch of particles will burst from the sun in a solar flare, which can disrupt satellite communications and knock out power on Earth. Flares usually stem from the activity of sunspots, cool regions of the photosphere that form and dissipate as the sun's internal magnetic field shifts. Solar flares and sunspots obey a regular cycle, rising and falling in number every 11 years as the poles of the sun's magnetic field flip back and forth.Sometimes, the sun will also launch huge bubbles of magnetized particles from its corona, in events called coronal mass ejections (CMEs). Some CMEs can grow as large as the sun itself and fling as much as a billion tons of material in a given direction. As they rush from the sun, CMEs can send huge shockwaves through the solar wind. If a CME collided with Earth, its particles could pack enough power to fry electronics in orbit and on Earth's surface.Like many energy sources, the sun will not last forever. It has already used up nearly half of the hydrogen in its core. The sun will continue to burn through the hydrogen for another five billion years or so, and then helium will become its primary fuel. At that point, the sun will expand to about a hundred times its current size, swallowing Mercury and Venusand maybe Earth. It will burn as a red giant star for another billion years and then collapse into a white dwarf star. The sun is comprised of many layers that work together to produce energy.From the Earth, the sun looks rather small. In reality, the diameter of the sun is around 860,000 miles. The Earth can fit around the sun 109 times. It is the closest star to the earth with a distance of 93 million miles. The sun is made of several complex layers, each with its own unique job that ultimately produces energy. This energy controls the Earths climate and weather and provides life for all living things on earth.Core: The Inner Layer The heat from the core is 15 million degrees Kelvin which translates to roughly 27 million degrees Fahrenheit. Kelvin is a temperature scale that picks up where the Celsius degree ends. The core is comprised of a radiative layer that emits radiation and a convective layer that transfers heat. The heat inside the core causes protons and electrons to rub together creating an energy source for the Sun.The Radiation ZoneThe radiation zone is just outside the core. The function of this layer is to transfer energy from the core to the other layers. The temperature at this layer is cooler than the core at 7 million degrees Fahrenheit causing thermal radiation. This layer has 60 percent mass and 90 percent volume.The Convection ZoneThe convection zone is not dense enough to transmit energy. Instead, this layer moves heat to the surface of the sun where it cools and drops back into the convection zone where it reheats.Photosphere Gives the Sun ColorThe photosphere is the layer that can be seen from the Earth. The temperature of the photosphere is about 10 million degrees Fahrenheit. The surface of this area can be seen through a telescope. Chromosphere can be seen during an EclipseAbove the photosphere is the suns solar atmosphere that includes the chromosphere. It is the same diameter as the Earth and is about 35 million degrees Fahrenheit. Sometimes the chromosphere can be seen during an eclipse.Corona: The Outer LayerThe outermost layer is the corona and can be seen during a solar eclipse when the sun is blocked by the moon. This layer is hotter than the surface of the sun.The sun has many chemical elements but since it is so hot they are in a gaseous state. The color of the sun is actually white, but from Earth, it appears yellow. The sun is so dense that there is no surface. For more information on the suns layers and temperatures visit the National Aeronautics and Space Administration. Science Astronomy The energy radiated by the Sun is produced during the conversion of hydrogen (H) atoms to helium (He). The Sun is at least 90 percent hydrogen by number of atoms, so the fuel is readily available. Since one hydrogen atom weighs 1.0078 atomic mass units and a single helium atom weighs 4.0026, the conversion of four hydrogen atoms to one helium atom yields 0.0294 mass unit, which are all converted to energy, 6.8 million electron volts (MeV, 1 MeV = 1.6 106 erg), in the form of gamma () rays or the kinetic energy of the products. If all the hydrogen is converted, 0.7 percent of the mass becomes energy, according to the Einstein formula E = mc2, in which E represents the energy, m is the mass, and c is the speed of light. A calculation of the time required to convert all the hydrogen in the Sun provides an estimate of the length of time for which the Sun can continue to radiate energy. In only about 10 percent of the Sun are the temperatures high enough to sustain fusion reactions. Converting 0.7 percent of the 2 1032 grams of hydrogen into energy that is radiated at 4 1033 ergs per second permits the Sun to shine for 3 1017 seconds, or 10 billion years at the present rate. The process of energy generation results from the enormous pressure and density at the centre of the Sun, which makes it possible for nuclei to overcome electrostatic repulsion. (Nuclei are positive and thus repel each other.) Once in some billions of years a given proton (1H, in which the superscript represents the mass of the isotope) is close enough to another to undergo a process called inverse beta decay, in which one proton becomes a neutron and combines with the second to form a deuteron (2D). This is shown symbolically on the first line of equation 1, in which e is an electron and is a subatomic particle known as a neutrino. While this is a rare event, hydrogen atoms are so numerous that it is the main solar energy source. Subsequent encounters (listed on the second and third lines) proceed much faster: the deuteron encounters one of the ubiquitous protons to produce helium-3 (3He), and these in turn form helium-4 (4He). The net result is that four hydrogen atoms are fused into one helium atom. The energy is carried off by gamma-ray photons () and neutrinos, . Because the nuclei must have enough energy to overcome the electrostatic barrier, the rate of energy production varies as the fourth power of the temperature. Equation 1 shows that for every two hydrogen atoms converted, one neutrino of average energy 0.26 MeV carrying 1.3 percent of the total energy released is produced. This produces a flux of 8 1010 neutrinos per square centimetre per second at Earth. The first experiment designed to detect solar neutrinos was built in the 1960s by American scientist Raymond Davis (for which he won the Nobel Prize for Physics in 2002) and carried out deep underground in the Homestake gold mine in Lead, South Dakota, U.S. The solar neutrinos in equation 1 had an energy (less than 0.42 MeV) that was too low to be detected by this experiment; however, subsequent processes produced higher energy neutrinos that Daviss experiment could detect. The number of these higher energy neutrinos observed was far smaller than would be expected from the known energy-generation rate, but experiments established that these neutrinos did in fact come from the Sun. This discrepancy became known as the solar neutrino problem. One possible reason for the small number detected was that the presumed rates of the subordinate process are not correct. Another, more intriguing, possibility was that the neutrinos produced in the core of the Sun interact with the vast solar mass and change to a different kind of neutrino that cannot be observed. The existence of such a process would have great significance for nuclear theory, for it requires a small mass for the neutrino. In 2002 results from the Sudbury Neutrino Observatory, nearly 2,100 metres (6,800 feet) underground in the Creighton nickel mine near Sudbury, Ontario, Canada, showed that the solar neutrinos did change their type and thus that the neutrino had a small mass. These results solved the solar neutrino problem. In addition to being carried away as neutrinos, which simply disappear into the cosmos, the energy produced in the core of the Sun takes two other forms as well. Some is released as the kinetic energy of product particles, which heats the gases in the core, while some travels outward as gamma-ray photons until they are absorbed and reradiated by the local atoms. Because the nuclei at the core are completely ionized, or stripped of their electrons, the photons are simply scattered there into a different path. The density is so high that the photons travel only a few millimetres before they are scattered. Farther out the nuclei have electrons attached, so they can absorb and reemit the photons, but the effect is the same: the photons take a so-called random walk outward until they escape from the Sun. The distance covered in a random walk is the average distance traveled between collisions (known as the mean free path) multiplied by the square root of the number of steps, in which a step is an interval between successive collisions. As the average mean free path in the Sun is about 10 centimetres (4 inches), the photon must take 5 1019 steps to travel 7 1010 centimetres. Even at the speed of light this process takes 170,000 years, and so the light seen today was generated long ago. The final step from the Suns surface to Earth, however, takes only eight minutes. As photons are absorbed by the outer portion of the Sun, the temperature gradient increases and convection occurs. Great currents of hot plasma, or ionized gas, carry heat upward. These mass motions of conducting plasma in the convective zone, which constitutes approximately the outer 30 percent of the Sun, may be responsible for the sunspot cycle. The ionization of hydrogen plays an important role in the transport of energy through the Sun. Atoms are ionized at the bottom of the convective zone and are carried upward to cooler regions, where they recombine and liberate the energy of ionization. Just below the surface, radiation transport again becomes efficient, but the effects of convection are clearly visible in the photosphere. The four layers of the Sun are the core, radiative zone, convective zone, and atmosphere.The Sun is a colossal nuclear reactor at the heart of our solar system. Our favorite star is about 109 times the diameter of Earth and over 330,000 times its mass. It generates energy through nuclear fusion at its core, where temperatures and pressures are unimaginably high. This energy radiates into space, providing the light and heat essential for life on Earth. Understanding the Suns structure is crucial for comprehending various solar phenomena that affect our planet, such as solar flares and space weather.The Sun consists of several distinct layers, each with unique properties and processes. These layers fall into two main sections: the solar atmosphere and the solar interior. Or, since the interior layers are so large, the four layers of the Sun are its atmosphere, convective zone radiative zone, and core.AtmosphereConvective ZoneRadiative ZoneCoreThe solar atmosphere is the outermost region of the Sun, visible during total solar eclipses. It consists of three primary layers:PhotosphereThickness/Size: Approximately 500 kilometers.Temperature: Around 5,500C.Characteristics: The photosphere is the Suns visible surface, where light is emitted that we see from Earth. Its marked by granules and sunspots, which are manifestations of the Suns magnetic activity. Below this layer, the Sun is opaque to visible light.ChromosphereThickness/Size: Roughly 2,000 kilometers above the photosphere.Temperature: 4,000C near the bottom, but increases with altitude up to 20,000C.Characteristics: This layer is visible as a red rim during solar eclipses, caused by hydrogen emissions. The chromosphere is home to spicules and solar prominences, dynamic jets, and arcs of solar material.CoronaThickness/Size: Extends millions of kilometers into space.Temperature: Surprisingly, its much hotter than the layers below, reaching over a million degrees Celsius.Characteristics: The corona is the outermost part of the solar atmosphere, visible as a white halo during eclipses. Its where solar winds originate and is the source of coronal mass ejections (CMEs).The transition layer is a thin, irregular layer or boundary that separates the hot corona from the relatively cool chromosphere. Beyond the corona lies the heliosphere. The heliosphere is the outermost layer of the solar atmosphere and is analogous to the Earths magnetosphere. It has the shape of a large tailed bubble around the Sun and planets, separating the solar system from the interstellar medium as the star travels through space.The outer surface of the Sun is home to some interesting phenomena, such as solar prominences, flares, sunspots, and coronal holes:Solar prominences are immense clouds of relatively cooler, dense plasma suspended above the Suns surface by the Suns magnetic field. They appear as bright, loop-like structures when viewed against the dark backdrop of space, but as dark filaments against the bright solar disk.Where They Occur:Prominence are visible within the Suns chromosphere, but their roots often extend into the photosphere and they frequently project into the lower corona.Solar flares are intense bursts of radiation emanating from the release of magnetic energy associated with sunspots. These appear as bright areas on the Sun and are powerful enough to influence Earths ionosphere, affecting communication and navigation systems.Where They Occur:Flares typically originate in the Suns chromosphere, though their effects are visible in the corona.Sunspots are temporary phenomena on the photosphere of the Sun that appear as spots darker than the surrounding areas. They are caused by concentrations of magnetic field flux that inhibit convection, resulting in reduced surface temperature compared to the surrounding regions.Where They Occur:Sunspots are exclusively features of the Suns photosphere.Coronal holes are regions in the Suns corona that appear darker and are cooler and less dense than the surrounding areas. These regions are sources of high-speed solar wind particles, a stream of charged particles that extend out into space.Beneath the solar atmosphere lies the solar interior, comprising three major layers:Convective Zone:Thickness/Size: Extends from about 70% of the Suns radius to the photosphere.Temperature: Decreases from about 2 million C to 5,500C as it approaches the photosphere.Characteristics: In this layer, hot plasma rises, cools as it nears the surface, and sinks back down, creating convection currents. This process produces the granulation seen on the photosphere.Radiative Zone:Thickness/Size: Stretches from 20% to 70% of the Suns radius.Temperature: Ranges from 2 million C to 7 million C.Characteristics: Energy generated in the core moves outward through the radiative zone via radiation. Photons (light particles) bounce around in this zone, taking a long time to travel through.Core:Thickness/Size: Extends to about 20% of the Suns radius.Temperature: Around 15 million C.Characteristics: The core is the powerhouse of the Sun. This is where nuclear fusion occurs, converting hydrogen into helium. This process releases the energy that eventually reaches the surface and radiates into space.The tachocline is a transition layer that separates the convective and radiative zones.Energy Generation in the Core: The core is the hottest part of the Sun, where temperatures reach about 15 million degrees Celsius. Fusion results from self-correcting equilibrium. If fusion occurs at a higher rate, the core heats up and expands slightly. This reduces its density, which then lowers the fusion rate. Meanwhile, if fusion slows, the core shrinks and cools, increasing density and the fusion rate.Radiative Zones Role in Energy Transport: In the radiative zone, photons transport energy from the core. This zone doesnt have the convection currents seen in the outer layers. Instead, radiation transfers energy.Tachoclines Mystery: The tachocline is a region of sharp change in rotation. The differential rotation of this layer may play a crucial role in generating the Suns magnetic field.Granulation on the Photosphere: The photosphere displays a grainy texture known as granulation. These granules are the tops of convection cells where hot plasma rises, cools, and then sinks back down.Chromospheres Spicules: The chromosphere, just above the photosphere, features dynamic jet-like structures called spicules. These spicules shoot up to 10,000 kilometers into the Suns atmosphere at speeds of up to 20 kilometers per second.Coronas High Temperature Mystery: The corona, the Suns outermost layer, has temperatures exceeding a million degrees Celsius, which is paradoxically much hotter than the surface.Helioseismology for Studying the Suns Interior: Scientists use a technique called helioseismology to study the Suns internal structure. By analyzing waves and oscillations on the Suns surface, they infer details about the interior layers.Solar Cycle and Magnetic Field: The Suns magnetic field goes through a cycle, approximately every 11 years, known as the solar cycle. This cycle changes the number and location of sunspots and influences various solar phenomena, including solar flares and coronal mass ejections.Erdlyi, R.; Ballai, I. (2007). Heating of the solar and stellar coronae: a review. Astron. Nachr. 328 (8): 726733. doi:10.1002/asna.200710803Phillips, K.J.H. (1995). Guide to the Sun. Cambridge University Press. ISBN 978-0-521-39788-9.Shu, F.H. (1991). The Physics of Astrophysics. Vol. 1. University Science Books. ISBN 978-0-935702-64-4.Solanki, S.K.; Livingston, W.; Ayres, T. (1994). New Light on the Heart of Darkness of the Solar Chromosphere. Science. 263 (5143): 6466. doi:10.1126/science.263.5143.64Zeilik, M.A.; Gregory, S.A. (1998). Introductory Astronomy & Astrophysics (4th ed.). Saunders College Publishing. ISBN 978-0-03-006228-5.Related Posts The sun the most massive object in the solar system is a population I yellow dwarf star. It's at the heavier end of its class of stars, and its population I status means it contains heavy elements. The only elements in the core, however, are hydrogen and helium; hydrogen is the fuel for nuclear fusion reactions that continuously produce helium and energy. At present, the sun has burned about half of its fuel. According to the nebular hypothesis, the sun came into being as a result of the gravitational collapse of a nebula a large cloud of space gas and dust. As this cloud attracted more and more matter to its core, it began to spin on an axis, and the central part began to heat up under the enormous pressures created by the addition of more and more dust and gases. At a critical temperature 10 million degrees Celsius (18 million degrees Fahrenheit) the core ignited. The fusion of hydrogen into helium created an outward pressure that counteracted gravity to produce a steady state that scientists call the "main sequence." The sun looks like a featureless yellow orb from Earth, but it has discrete internal layers. The central core, which is the only place that nuclear fusion happens, extends to a radius of 138,000 kilometers (86,000 miles). Beyond that, the radiative zone extends nearly three times as far, and the convective zone reaches to the photosphere. At a radius of 695,000 kilometers (432,000 miles) from the center of the core, the photosphere is the deepest layer that astronomers can observe directly, and is the closest the sun has to a surface. The temperature at the sun's core is around 15 million degrees Celsius (28 million degrees Fahrenheit), which is almost 3,000 time higher than at the surface. The core is 10 times as dense as gold or lead, and the pressure is 340 billion times the atmospheric pressure on Earth's surface. The core and radiative zones are so dense that photons produced by reactions in the core take a million years to reach the convective layer. At the beginning of that semi-opaque layer, temperatures have cooled enough to allow heavier elements, such as carbon, nitrogen, oxygen and iron to retain their electrons. The heavier elements trap light and heat, and the layer ultimately "boils," transferring energy to the surface by convection. Deziel, Chris. "Facts About The Sun's Core" sciencing.com, . 24 April 2017. APA Deziel, Chris. (2017, April 24). Facts About The Sun's Core. sciencing.com. Retrieved from Chicago Deziel, Chris. Facts About The Sun's Core last modified March 24, 2022. The Sun's core is the central region where nuclear reactions consume hydrogen to form helium. These reactions release the energy that ultimately leaves the surface as visible light. These reactions are highly sensitive to temperature and density. The individual hydrogen nuclei must collide with enough energy to give a reasonable probability of overcoming the repulsive electrical force between these two positively charged particles. The temperature at the very center of the Sun is about 15,000,000 C (27,000,000 F) and the density is about 150 g/cm (approximately 10 times the density of gold, 19.3 g/cm or lead, 11.3 g/cm). Both the temperature and the density decrease as one moves outward from the center of the Sun. The nuclear burning is almost completely shut off beyond the outer edge of the core (about 25% of the distance to the surface or 175,000 km from the center). At that point the temperature is only half its central value and the density drops to about 20 g/cm. THE STRUCTURE OF THE SUN The image of the sun shown below illustrates 3 parts of the Sun's structure. The core is the innermost 10% of the Sun's mass. It is where the energy from nuclear fusion is generated. Because of the enormous amount of gravity compression from all of the layers above it, the core is very hot and dense. Nuclear fusion requires extremely high temperatures and densities. The Sun's core is about 16 million degrees hot and has a density around 160 grams/centimeter3. This is over 20 times denser than the dense metal Iron which has a density of "only'' 7 grams/centimeter3. However, the Sun's interior is still gaseous all the way to the core because of the extreme temperatures. There is no molten rock like we find in the interior of the Earth. The radiative zone is where the energy is transported from the superhot interior to the colder outer layers by photons. Technically, this also includes the core. The radiative zone includes the inner approximately 85% of the Sun's radius. Energy in the outer 15% of the Sun's radius is transported by the bulk motions of gas in a process called convection. At cooler temperatures, more ions are able to block the outward flow of photon radiation more effectively, so nature kicks in convection to help the Sun transport its energy. This part of the Sun just below the surface is called the convection zone. The image to the right shows the internal structure of the Sun. Move the mouse pointer over the core to start the animation. COOKIES To enable the sharing functionality, please accept all cookies. To adjust your cookie settings, click here. Introduction The Sun is a 4.5 billion-year-old yellow dwarf star a hot glowing ball of hydrogen and helium at the center of our solar system. Its about 93 million miles (150 million kilometers) from Earth and its our solar systems only star. Without the Suns energy, life as we know it could not exist on our home planet. From our vantage point on Earth, the Sun may appear like an unchanging source of light and heat in the sky. But the Sun is a dynamic star, constantly changing and sending energy out into space. The science of studying the Sun and its influence throughout the solar system is called heliophysics. The Sun is the largest object in our solar system. Its diameter is about 865,000 miles (1.4 million kilometers). Its gravity holds the solar system together, keeping everything from the biggest planets to the smallest bits of debris in orbit around it. Even though the Sun is the center of our solar system and essential to our survival, its only an average star in terms of its size. Stars up to 100 times larger have been found. And many solar systems have more than one star. By studying our Sun, scientists can better understand the workings of distant stars. The hottest part of the Sun is its core, where temperatures top 27 million F (15 million C). The part of the Sun we call its surface the photosphere is a relatively cool 10,000 F (5,500 C). In one of the Suns biggest mysteries, the Suns outer atmosphere, the corona, gets hotter the farther it stretches from the surface. The corona reaches up to 3.5 million F (2 million C) much, much hotter than the photosphere. Dec. 2, 2020, marked the 25th anniversary of the Solar and Heliospheric Observatory, or SOHO. Since its launch, the mission has kept watch on the Sun. Namesake Namesake The Sun has been called by many names. The Latin word for Sun is sol, which is the main adjective for all things Sun-related: solar. Helios, the Sun god in ancient Greek mythology, lends his name to many Sun-related terms as well, such as heliosphere and helioseismology. Potential for Life Potential for Life The Sun could not harbor life as we know it because of its extreme temperatures and radiation. Yet life on Earth is only possible because of the Suns light and energy. Size and Distance Size and Distance Our Sun is a medium-sized star with a radius of about 435,000 miles (700,000 kilometers). Many stars are much larger but the Sun is far more massive than our home planet: it would take more than 330,000 Earths to match the mass of the Sun, and it would take 1.3 million Earths to fill the Sun's volume. The Sun is about 93 million miles (150 million kilometers) from Earth. Its nearest stellar neighbor is the Alpha Centauri triple star system: red dwarf star Proxima Centauri is 4.24 light-years away, and Alpha Centauri A and B two sunlike stars orbiting each other are 4.37 light-years away. A light-year is the distance light travels in one year, which equals about 6 trillion miles (9.5 trillion kilometers). Orbit and Rotation Orbit and Rotation The Sun is located in the Milky Way galaxy in a spiral arm called the Orion Spur that extends outward from the Sagittarius arm. This illustration shows the spiral arms of our Milky Way galaxy. Our Sun is in the Orion Spur. Credit: NASA/Adler/U. Chicago/Wesleyan/JPL-Caltech | Full caption and image The Sun orbits the center of the Milky Way, bringing with it the planets, asteroids, comets, and other objects in our solar system. Our solar system is moving with an average velocity of 450,000 miles per hour (720,000 kilometers per hour). But even at this speed, it takes about 230 million years for the Sun to make one complete trip around the Milky Way. The Sun rotates on its axis as it revolves around the galaxy. Its spin has a tilt of 7.25 degrees with respect to the plane of the planets orbits. Since the Sun is not solid, different parts rotate at different rates. At the equator, the Sun spins around once about every 25 Earth days, but at its poles, the Sun rotates once on its axis every 36 Earth days. Moons As a star, the Sun doesnt have any moons, but the planets and their moons orbit the Sun. Rings Rings The Sun would have been surrounded by a disk of gas and dust early in its history when the solar system was first forming, about 4.6 billion years ago. Some of that dust is still around today, in several dust rings that circle the Sun. They trace the orbits of planets, whose gravity tugs dust into place around the Sun. Formation Formation The Sun formed about 4.6 billion years ago in a giant, spinning cloud of gas and dust called the solar nebula. As the nebula collapsed under its own gravity, it spun faster and flattened into a disk. Most of the nebula's material was pulled toward the center to form our Sun, which accounts for 99.8% of our solar systems mass. Much of the remaining material formed the planets and other objects that now orbit the Sun. (The rest of the leftover gas and dust was blown away by the young Sun's early solar wind.) Like all stars, our Sun will eventually run out of energy. When it starts to die, the Sun will expand into a red giant star, becoming so large that it will engulf Mercury and Venus, and possibly Earth as well. Scientists predict the Sun is a little less than halfway through its lifetime and will last another 5 billion years or so before it becomes a white dwarf. Structure Structure The Sun is a huge ball of hydrogen and helium held together by its own gravity. The Sun has several regions. The interior regions include the core, the radiative zone, and the convection zone. Moving outward the visible surface or photosphere is next, then the chromosphere, followed by the transition zone, and then the corona the Suns expansive outer atmosphere. Once material leaves the corona at supersonic speeds, it becomes the solar wind, which forms a huge magnetic "bubble" around the Sun, called the heliosphere. The heliosphere extends beyond the orbit of the planets in our solar system. Thus, Earth exists inside the Suns atmosphere. Outside the heliosphere is interstellar space. The core is the hottest part of the Sun. Nuclear reactions here where hydrogen is fused to form helium power the Suns heat and light. Temperatures top 27 million F (15 million C) and its about 86,000 miles (138,000 kilometers) thick. The density of the Suns core is about 150 grams per cubic centimeter (g/cm). That is approximately 8 times the density of gold (19.3 g/cm) or 13 times the density of lead (11.3 g/cm). Energy from the core is carried outward by radiation. This radiation bounces around the radiative zone, taking about 170,000 years to get from the core to the top of the convection zone. Moving outward, in the convection zone, the temperature drops below 3.5 million F (2 million C). Here, large bubbles of hot plasma (a soup of ionized atoms) move upward toward the photosphere, which is the layer we think of as the Sun's surface. Surface Surface The Sun doesnt have a solid surface like Earth and the other rocky planets and moons. The part of the Sun commonly called its surface is the photosphere. The word photosphere means "light sphere" which is apt because this is the layer that emits the most visible light. Its what we see from Earth with our eyes. (Hopefully, it goes without saying but never look directly at the Sun without protecting your eyes.) Although we call it the surface, the photosphere is actually the first layer of the solar atmosphere. It's about 250 miles thick, with temperatures reaching about 10,000 degrees Fahrenheit (5,500 degrees Celsius). That's much cooler than the blazing core, but it's still hot enough to make carbon like diamonds and graphite not just melt, but boil. Most of the Sun's radiation escapes outward from the photosphere into space. Atmosphere Atmosphere Above the photosphere is the chromosphere, the transition zone, and the corona. Not all scientists refer to the transition zone as its own region it is simply the thin layer where the chromosphere rapidly heats and becomes the corona. The photosphere, chromosphere, and corona are all part of the Suns atmosphere. (The corona is sometimes casually referred to as the Suns atmosphere, but it is actually the Suns upper atmosphere.) The Suns atmosphere is where we see features such as sunspots, coronal holes, and solar flares. Visible light from these top regions of the Sun is usually too weak to be seen against the brighter photosphere, but during total solar eclipses, when the Moon covers the photosphere, the chromosphere looks like a fine, red rim around the Sun, while the corona forms a beautiful white crown ("corona" means crown in Latin and Spanish) with plasma streamers narrowing outward, forming shapes that look like flower petals. In one of the Suns biggest mysteries, the corona is much hotter than the layers immediately below it. (Imagine walking away from a bonfire only to get warmer.) The source of coronal heating is a major unsolved puzzle in the study of the Sun. Magnetosphere Magnetosphere The Sun generates magnetic fields that extend out into space to form the interplanetary magnetic field the magnetic field that pervades our solar system. The field is carried through the solar system by the solar wind a stream of electrically charged gas blowing outward from the Sun in all directions. The vast bubble of space dominated by the Suns magnetic field is called the heliosphere. Since the Sun rotates, the magnetic field spins out into a large rotating spiral, known as the Parker spiral. This spiral has a shape something like the pattern of water from a rotating garden sprinkler. The Sun doesn't behave the same way all the time. It goes through phases of high and low activity, which make up the solar cycle. Approximately every 11 years, the Suns geographic poles change their magnetic polarity that is, the north and south magnetic poles swap. During this cycle, the Sun's photosphere, chromosphere, and corona change from quiet and calm to violently active. The height of the Suns activity cycle, known as solar maximum, is a time of greatly increased solar storm activity. Sunspots, eruptions called solar flares, and coronal mass ejections are common at solar maximum. The latest solar cycle Solar Cycle 25 started in December 2019 when solar minimum occurred, according to the Solar Cycle 25 Prediction Panel, an international group of experts co-sponsored by NASA and NOAA. Scientists now expect the Suns activity to ramp up toward the next predicted maximum in July 2025. Solar activity can release huge amounts of energy and particles, some of which impact us here on Earth. Much like weather on Earth, conditions in space known as space weather are always changing with the Suns activity. "Space weather" can interfere with satellites, GPS, and radio communications. It also can cripple power grids, and corrode pipelines that carry oil and gas. The strongest geomagnetic storm on record is the Carrington Event, named for British astronomer Richard Carrington who observed the Sept. 1, 1859, solar flare that triggered the event. Telegraph systems worldwide went haywire. Spark discharges shocked telegraph operators and set their telegraph paper on fire. Just before dawn the next day, skies all over Earth erupted in red, green, and purple auroras the result of energy and particles from the Sun interacting with Earths atmosphere. Reportedly, the auroras were so brilliant that newspapers could be read as easily as in daylight. The auroras, or Northern Lights, were visible as far south as Cuba, the Bahamas, Jamaica, El Salvador, and Hawaii. Another solar flare on March 13, 1989, caused geomagnetic storms that disrupted electric power transmission from the Hydro Qubec generating station in Canada, plunging 6 million people into darkness for 9 hours. The 1989 flare also caused power surges that melted power transformers in New Jersey. In December 2005, X-rays from a solar storm disrupted satellite-to-ground communications and Global Positioning System (GPS) navigation signals for about 10 minutes. NOAAs Space Weather Prediction Center monitors active regions on the Sun and issues watches, warnings, and alerts for hazardous space weather events. Resources Resources

Define the core of the sun. What does the core of the sun do. What happens in the core of the sun. Where is the core of the sun located. The core of the sun definition. The core of the sun.